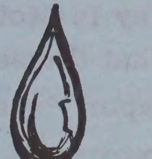
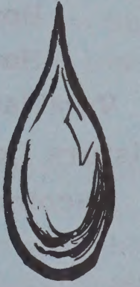
CONDENSATION CONTROL for Alaskan Homes





COOPERATIVE EXTENSION SERVICE
University of Alaska

PUBLICATION NO. 52

PAM:697.147
BRA

POLAR
PAM
5124
POLARPAM

e 1972

CONTENTS

Why Is Moisture Condensation A Problem? 1
What Causes Moisture Condensation? 3
Vapor Pressure 4
Sources of Moisture and Methods of Control 6
    Elimination 6
    Isolation 7
        Where is a vapor barrier placed? 8
        How is a vapor barrier installed? 11
        How to prevent vapor barrier damage . . . 12
    Ventilation 13
Moisture Control and Thermal Insulation 17
    Recommended Moisture Control Procedure . . 18

The original version of this bulletin was published in 1954 by C. R. Fahnestock and C. I. Branton, and revised by C. I. Branton in 1957 and 1960. Revised by C. I. Branton and E. O. Eaton in 1965.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Dr. James W. Matthews, Director, Cooperative Extension Service, University of Alaska.

CONDENSATION CONTROL FOR ALASKAN HOMES

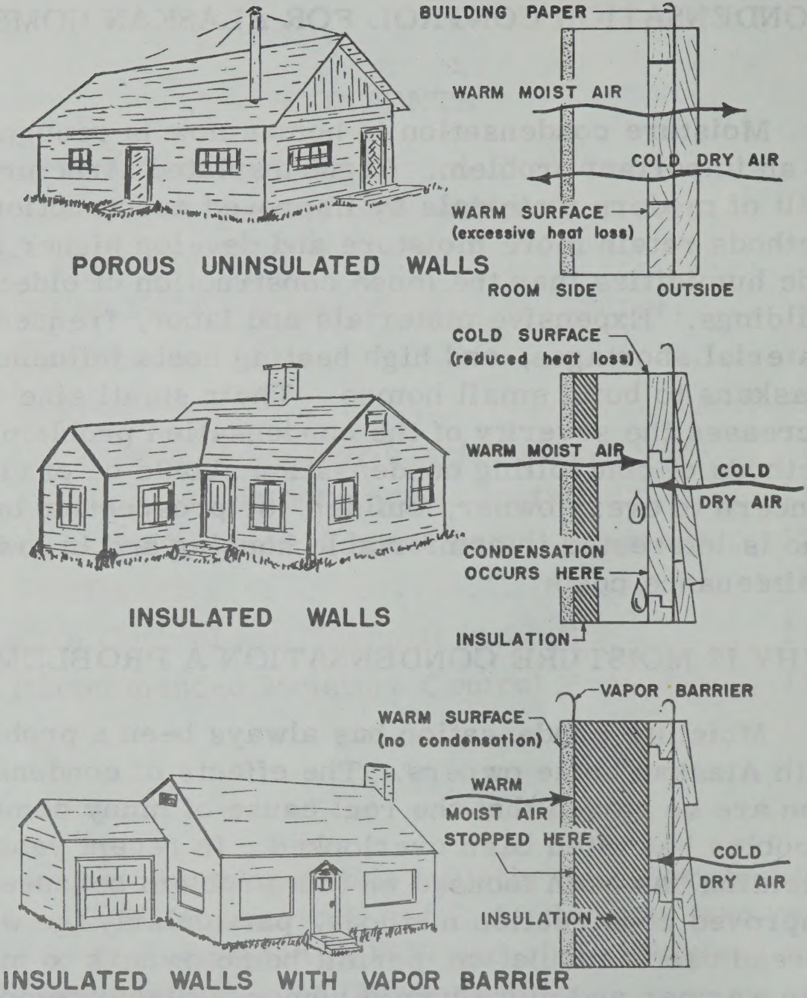
Moisture condensation in homes now is recognized as an important problem. Tight insulated structures built of modern materials by improved construction methods retain more moisture and develop higher inside humidities than the loose construction of older buildings. Expensive materials and labor, frequent material shortages, and high heating costs influence Alaskans to build small homes. Their small size increases the severity of the condensation problem. Methods of controlling condensation should be of vital concern to every owner, builder, or prospective buyer who is interested in comfortable housing and in low maintenance costs.

WHY IS MOISTURE CONDENSATION A PROBLEM?

Moisture condensation has always been a problem with Alaskan home owners. The effects of condensation are so varied that the real cause of many common troubles has often been overlooked. In recent years attention has been focused on this problem because improved construction methods, particularly the widespread use of insulation, permit home owners to maintain warmer and more humid homes. Higher temperature and humidity enhance the destructive features of excessive condensation.

Condensation seldom occurs in older houses because they are so loosely constructed that the exchange of inside and outside air through cracks and around doors and windows is sufficient to remove the excessive water vapor, or humidity, within the house. Because there was no insulation, outside walls were relatively warm and condensation seldom occurred.

Rec'd: MAY 6 1974
BOREAL INSTITUTE
LIBRARY
Order No. 06833A
Price $ 0.25
Acc. No Coop. Ext. Serv.
14094



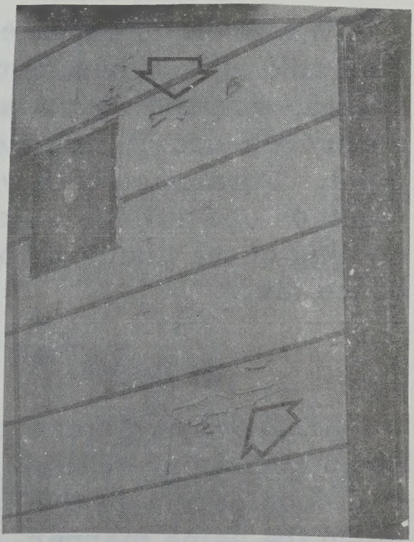
Evolution of condensation troubles in Alaskan homes. Early cabins had no condensation problem. Insulation, tight walls, and weather-stripping caused trouble in later houses. This can be reduced by an efficient vapor barrier and insulation.

Improved building practices such as weather-stripping, storm doors and sash, caulking, and insulation prevent warm moist air from leaking out of the house. Sometimes moisture is added to air to improve the comfort and health of the occupants. Water vapor accumulated within the house penetrates into wall, ceiling, and floor spaces where it condenses when it comes in contact with a cold surface. Exterior surfaces are kept cold by the insulation. These conditions may exist in most recently constructed homes and produce severe condensation problems.

Common visible evidences of condensation in dwellings are water-spots on walls and ceilings, peeling exterior paint, and deterioration of structural materials. Invisible damage often is greater because wooden structural members and many types of insulation rot or deteriorate as a result of moisture condensation on or within them.

WHAT CAUSES MOISTURE CONDENSATION?

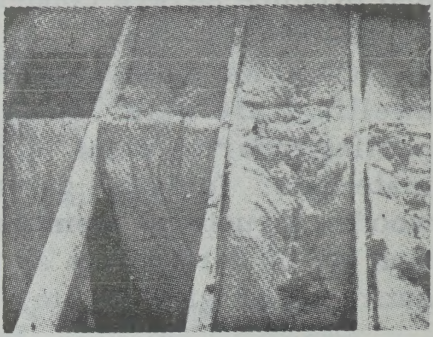
All air in a natural state contains water vapor. This vapor becomes visible when the air is brought in contact with a cool surface and water or frost is formed, depending upon whether the temperature of the surface is above or below 32° F. Familiar examples are the dew formed on a glass containing a cold drink and the frost on the freezing coils of a refrigerator. The accumulation of ice on the roof sheathing in attics is another example with which many Alaskans are familiar. Condensation is such a common occurrence that everyone should be familiar with principles governing it.



Moisture laden wood causes paint to peel. Extending the moisture barrier to the outside prevents this condition.

A definite volume of air can contain only a certain amount of water vapor at any particular temperature.

When the amount of water vapor present exceeds the amount which the air can hold, the moisture will begin to condense on the surfaces of the container or on dust particles in the air which then fall out as a fine mist or fog. The amount of water vapor in the air is usually less than the maximum amount that the air could hold. The ratio of the actual amount of water vapor in the air to the amount which the air could hold at that temperature is known as relative humidity and is customarily expressed in per cent.



Deterioration of bat insulation in ceiling of a 5-year old building, caused by lack of a vapor barrier.

Warm air is capable of holding more water vapor than cold air. When a quantity of moist warm air is cooled, a temperature is soon reached where condensation will occur. This temperature is called the dew point. Formation of dew or frost on vegetation is a common occurrence which is caused by night-time cooling of the plants below the dew point temperature of the air.

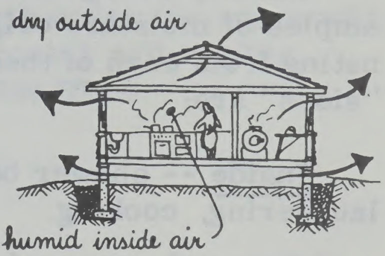
VAPOR PRESSURE

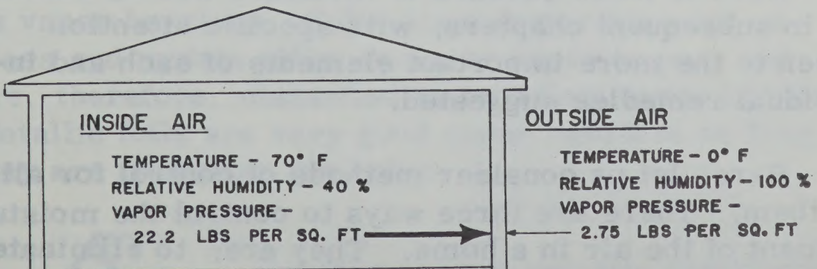
If you open a bottle of perfume in one corner of a room containing still air, the fragrance of the perfume will soon permeate the entire volume of the room. In much the same manner, the water vapor that is contained in air will mix uniformly throughout the air.

The water vapor tends to equalize its pressure by moving from an area of higher concentration to an area of lower concentration. Thus if water vapor is formed in one room of a house by cooking, laundering or bathing, it will tend to permeate the entire volume of the house until all the air in the house contains the same proportion of water vapor.

This tendency of water vapor to move from an area of high concentration to one of low concentration is caused by water vapor pressure. The more moisture air contains, the greater will be the pressure the moisture exerts. This vapor pressure will increase, too, with conditions of higher temperature and increased relative humidity.

During the winter months, when the outside air is cold and can hold much less moisture than the warm air inside the house, the vapor pressure indoors will be higher than it is outdoors. The water vapor, therefore, will seek to find its way to the cold outdoor air. In doing so, it will move outward by pressure, quite similar to the movement of steam by pressure.



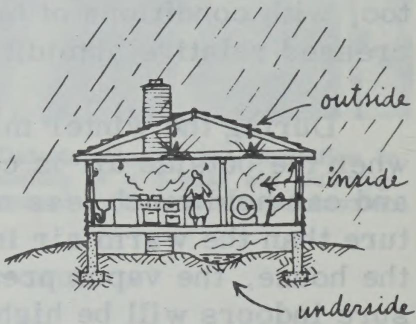


The difference in vapor pressures between the inside and outside of a house in Alaska may average 20 pounds per square foot for a large part of each year. Vapor pressure should not be confused with atmospheric pressure which normally is 14.7 pounds per square inch.

SOURCES OF MOISTURE AND METHODS OF CONTROL

Almost everyone will agree there are two sides to every discussion, but there are three sides to the discussion of moisture control in the home -- inside, underside and outside. For these are the areas in which lie the sources of moisture that may spell trouble for the homeowner --- and all of them must be considered.

Readily recognized examples of moisture originating from each of these "sides" are:



Inside -- shower baths, laundering, cooking.

Underside -- damp basements, leaky foundations, uncovered crawl spaces.

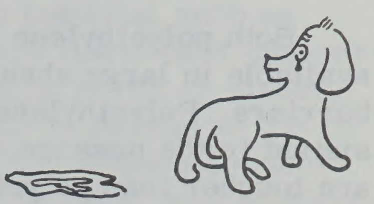
Outside -- roof leaks, faulty construction, driving rain.

Each of these sources of moisture will be discussed in subsequent chapters, with specific attention given to the more important elements of each and individual remedies suggested.

Here, let us consider methods of control for all of them. There are three ways to control the moisture content of the air in a home. They are: to eliminate, to isolate, and to ventilate.

ELIMINATION

The most logical and oftentimes the most practical way to reduce the water vapor in the air is to eliminate the moisture at its source. If moisture is eliminated at this point, it will have no possible chance to cause damage to the structure of the house.

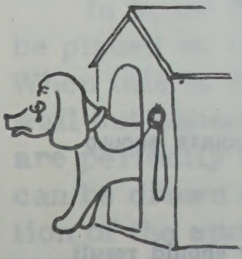


An example of this type of control would be the drainage of the building site into dry wells or sewer. Others would be the prompt repair of all leaks, venting of appliances to the chimney or outdoors, or covering exposed earth under the house with waterproofed concrete, heavy coated roll roofing, polyethylene or polyvinyl chloride films.

ISOLATION

It is sometimes impractical or even impossible to eliminate the moisture at its source. In this case, it is advisable to isolate the water vapor and stop its entrance into areas where it may cause trouble.

Materials that are highly resistant to the flow of water vapor are used for this purpose and are known as vapor barriers. Solid sheet materials such as glass and metals allow no water vapor to pass and are, therefore, classified as excellent vapor barriers. Metallic foils are very good vapor barriers as long as they are free from pin holes.

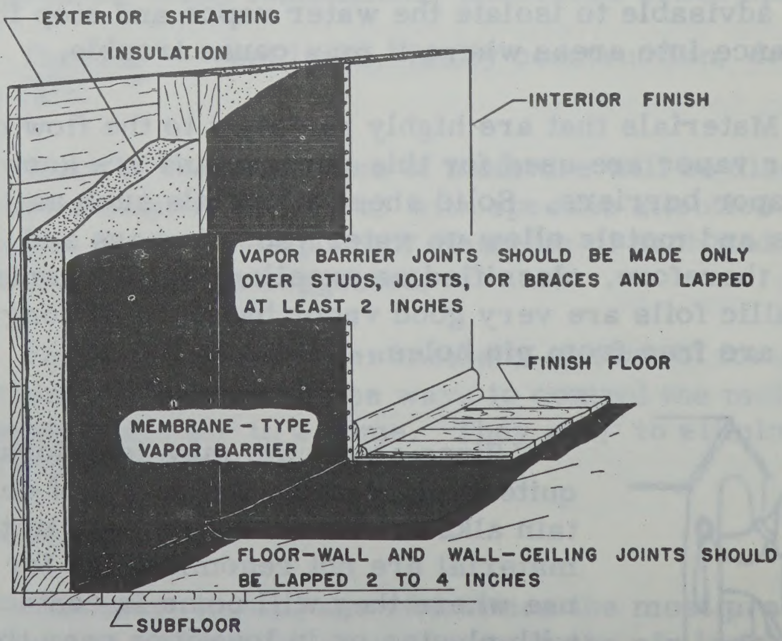


Since aluminum may deteriorate quite rapidly under the action of certain alkalis or salt water, foils of this material are not recommended for use where they will come in contact with plaster or in locations near the ocean. Coated asphalt felts having a continuous asphalt coating between the layers of paper, are reasonably good vapor barriers and may be used wherever a vapor barrier is required.

Both polyethylene and vinyl plastic materials are available in large sheets for use as membrane vapor barriers. Polyethylene material is somewhat more resistant to the passage of moisture vapor. Vinyl films are tougher than polyethylene. Either material resists deterioration indefinitely when installed in a wall.

Where Is A Vapor Barrier Placed?

Water vapor moves from an area of high vapor pressure to one of lower vapor pressure. To prevent its movement through a wall, a vapor barrier must be placed on or near the side with the higher vapor pressure. In a home, this is the inside or room side of the wall.


EXTERIOR SHEATHING
INSULATION
INTERIOR FINISH
VAPOR BARRIER JOINTS SHOULD BE MADE ONLY OVER STUDS, JOISTS, OR BRACES AND LAPPED AT LEAST 2 INCHES
FINISH FLOOR
MEMBRANE - TYPE VAPOR BARRIER
FLOOR-WALL AND WALL-CEILING JOINTS SHOULD BE LAPPED 2 TO 4 INCHES
SUBFLOOR

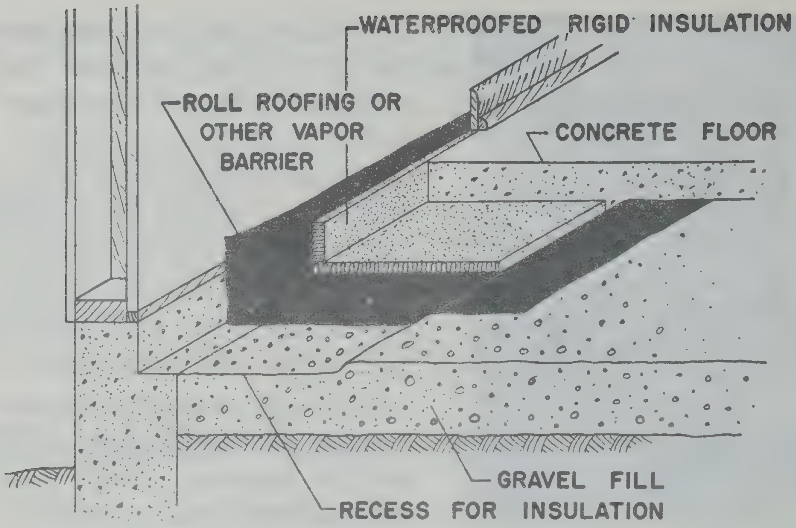
Proper application of a membrane-type vapor barrier should result in a vapor-tight envelope around all heated areas.

Wall openings require a continuous vapor barrier to the outside, marked by white arrow. Use waterproof glue or plastic tape to join special barrier to continuous inside barrier (not yet applied in this structure).

Most builders correctly put the vapor barrier immediately under interior finish material such as pressed fiberboard, plasterboard, plywood or plaster. It must be placed on the inside of the insulation and near the inner wall surface so that it remains warm enough to prevent condensation on its surface. The entire interior surface of the heated area of the house, including walls, ceilings, floors, closets, and stairwells, should be protected with a vapor barrier. Openings in either interior or exterior walls which connect the attic space with the basement or crawl space should be sealed with a vapor barrier to prevent upward migration of moisture.

When concrete floors are laid directly on the ground, plastic or other durable vapor barrier material must be placed over the gravel fill before the concrete floor is poured. This prevents the movement of water from the ground upward through the concrete.

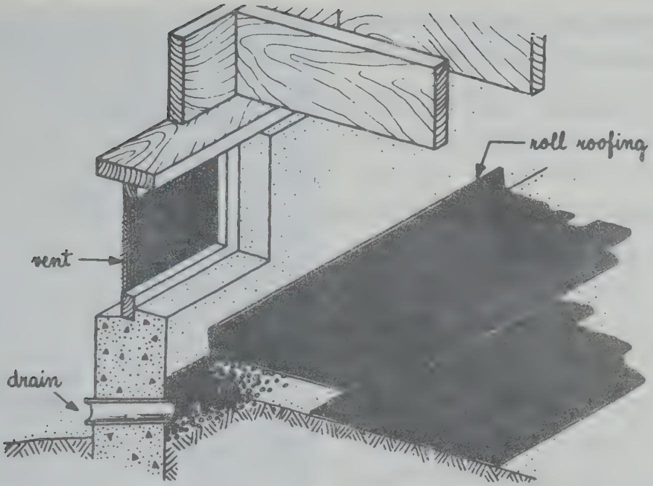
In home construction a vapor barrier should not be placed on both the inside and outside of a wall. When this is done moisture can accumulate within the wall but cannot escape. Even though both barriers are perfectly tight at the time of installation, moisture can be drawn into the walls by expansion and contraction of the enclosed air as a result of heating and cooling.


WATERPROOFED RIGID INSULATION
ROLL ROOFING OR OTHER VAPOR BARRIER
CONCRETE FLOOR
GRAVEL FILL
RECESS FOR INSULATION

Proper application of a moisture barrier in a concrete floor. Insulation should be provided to prevent excessive loss of heat to the outside through the foundation walls.

Existing homes with no internal vapor barrier may be protected by painting the inside surface of all exterior walls and ceilings with a good grade of paint having accredited vapor barrier qualities. If wallpaper is to be used, walls should first be given two coats of a good vapor barrier paint before the paper is applied. Coated fabric-type wall coverings are generally good vapor barriers. Wall linoleum and ceramic, metal or plastic tile are equally effective as vapor barriers.

Even though vapor barriers are used, it is still advisable to keep indoor humidities within recommended limits, for the barriers protect only the areas they cover. Usually window weight boxes and frames and door frames cannot be perfectly sealed and there is always the potential danger that some moisture may get into these areas and eventually cause trouble. With high indoor humidity, windows will sweat and there is danger of rotted window frames or ruined decorations from moisture dripping over window sills.



Moisture barrier in a crawl space floor.

How Is A Vapor Barrier Installed?

Since an effective vapor barrier must be continuous and unbroken to prevent passage of water vapor through or around it, poorly sealed joints, punctures, or tears make the vapor barrier practically worthless. For membrane-type barriers the following rules must be carefully observed.

* Floor-wall and wall-ceiling joints should be carefully made and lapped two to four inches.

* All other joints should be lapped at least two inches.

* Water-proof cement should be used at joints to get a tight seal.

* Lapped joints should be made over studs or braces so that pressure of the interior finishing material will secure and maintain a tight seal.

* All punctures, breaks, tears, and large holes made by nails, staples, or other fasteners should be patched and sealed.

* Openings around electrical and other outlets in walls and ceilings should be sealed.

* At doors and windows the vapor barrier should cover the frame and all openings.

The same rules generally apply to vapor barriers that are an integral part of the insulation. It is important to get a tight seal on each stud and an overlap of the vapor barrier flanges.

Where the vapor barrier is part of the wallboard used for interior finishing, the joints require special sealing to prevent entrance of moisture into the wall space. A tight seal also is necessary around electrical fixtures and around windows and doors. Best results are obtained by installing a membrane-type vapor barrier under the finish material. Regardless of how effective the material itself may be, it is difficult to seal the joints between sheets.

How to Prevent Vapor Barrier Damage

The effectiveness of any barrier is easily destroyed by lack of knowledge or care on the part of electricians, plumbers or carpenters. A mutual understanding of the purpose of a vapor barrier and a cooperative attitude toward keeping it intact is essential. The following precautions help preserve a vapor barrier:

* Avoid plumbing in outside walls. Breaks in vapor barriers are less harmful on inside walls. If necessary to have a water pipe in outside walls, put insulation between the pipe and the outside wall and a membrane barrier on the warm side of the pipe.

* Install as much of the electrical wiring as possible on inside walls. Where electrical boxes are needed on outside walls, use shallow boxes

Electrical outlet box installed on the warm side of the insulation and vapor barriers. Upper arrows mark stud locations and lower one indicates service wires entering near the inside edge of plate.

placed on the warm side of both the insulation and the vapor barrier. They can be fastened to sheathing plywood for support. Touch plate wiring can be installed with less chance of interfering with the performance of a vapor barrier than the older methods. Electrical service can be brought into a room through holes in a solid wood block imbedded in a frame or masonry wall. When this is done, caulking material around the wire completely seals it.

* Locations of studding and plates must be marked so that all nails are driven into a solid backing. Where the vapor barrier is squeezed tightly between two boards, little leakage occurs.

VENTILATION

The third way to control the moisture content of the air inside a home is to ventilate. The exchange of humid indoor air with dryer outdoor air by ventilation in winter should be used whether or not the other recommended controls are employed. It is the one sure method of keeping indoor humidity within safe limits. Large amounts of water vapor may be removed from a room merely by opening the window. Water vapor will go out through the opening instead of moving into the construction.

A ventilating fan, capable of providing a change of air every 15 or 20 minutes, furnishes more positive action in removing water vapor from the room. Automatic control may be accomplished by equipping a fan

with a humidity controller, of which several various types are available. Such a controller hooked up electrically to an exhaust fan has been used successfully to maintain indoor relative humidity within recommended limits.

This controller may be set to turn on the ventilating fan when the humidity in the room exceeds any set amount. By keeping the controller set at a safe limit, the home-owner can be assured that the humidity within the house will not become excessive.

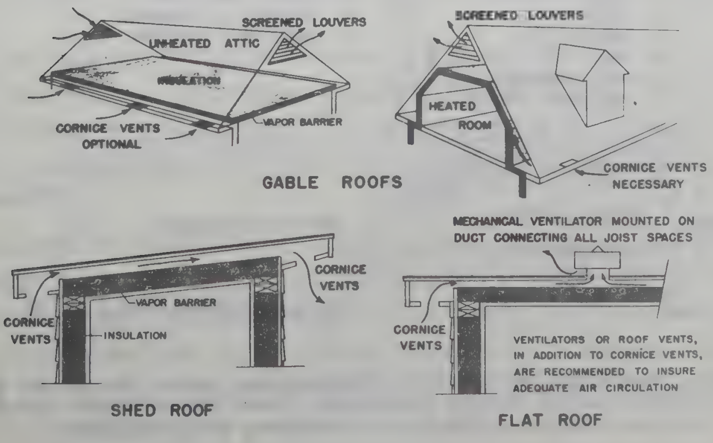
Ordinarily, a small amount of water vapor accumulates in the attic even though the living area is protected with a good vapor barrier. With no barrier, or a poor one, considerable amounts of moisture gather and condense as water or frost on the rafters and sheathing. Attic condensation is prevented by using louvers and vents which provide circulation of fresh outside air to remove excess moisture.

Vents for air intake are best installed under the eaves, and louvers for air outlets near the roof peak. If the attic is open and unheated, louvers located near the roof peak are satisfactory without eave vents. For gable roofs, there should be not less than one square foot of free inlet and one square foot of free outlet area for every 300 square feet of attic floor space. Roofs with flat slopes require double the ventilating area needed by roofs with steep slopes. If the ceiling is well insulated, openings larger than the minimum requirements will provide positive protection against condensation under the most adverse weather conditions. In addition to controlling condensation on the inside, colder roof temperatures help reduce icicle formation and glaciering on the exterior of the roof.

Louvers and vents should be evenly distributed to insure uniform ventilation of attic spaces. They must be screened to keep out insects and birds. Prevailing winds which might blow snow or rain into the attic will affect location of louvers. They should be kept open all year -- in the summer to remove excess heat and in the winter to prevent moisture condensation. All attic spaces should be interconnected or separately ventilated to the outside.

Large amounts of moisture accumulate in the basement of a house or in the crawl space under a

ATTIC AND ROOF VENTILATION



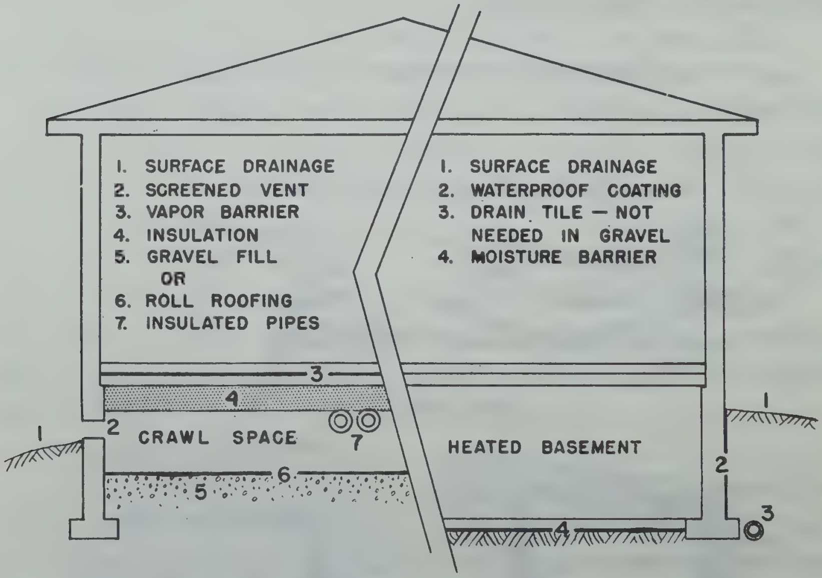
GABLE ROOFS

SHED ROOF

FLAT ROOF

basementless house. Most of this moisture comes from the ground and rises through the floors and wall spaces of the house. Some of it condenses on the under-surface of the house and deteriorates joists and other wooden structural members.

In addition to measures which reduce the amount of water vapor under the house, it is necessary to ventilate the crawl space to remove any moisture that does accumulate. Where no moisture barrier is used on the ground surface, the net area of ventilating louvers in foundation walls should be equal to two square feet per 100 linear feet of building perimeter plus one-half per cent of the building area. Thus, a 30 x 30 foot house requires 2.4 square feet plus 4.5 square feet, or about seven square feet of openings in the foundation walls. Where drainage is good and a moisture barrier is used on the ground, these recommendations may be reduced by as much as a half.



Methods of controlling moisture condensation under the house in crawl spaces and in heated basements. Crawl space vents should be open year-round to provide adequate air circulation.

Openings in the foundation walls must be screened to keep out trash, rodents, and birds. Closing devices should not be provided since it is desirable that the vents remain open for year-round ventilation regardless of the outside temperature. Insulation of the floor and any water or sewage pipes under the floor is necessary, but this expense is more than justified by permanent protection against deterioration of the floors, floor joists, and plates.

It is often impractical to insulate the floor and the pipes under an existing house so that the crawl space can be ventilated to the outside. Sometimes it is easier to seal and insulate the crawl space and provide a means of continuous air circulation with the air in the living area. This can be accomplished by circulating air from the crawl space through the heating plant.

Heated basements generally do not require special openings for the removal of excess moisture. If condensation is observed on the walls or ceiling, the excess humidity may be removed by opening windows, by an electric exhaust fan or dehumidifier.

MOISTURE CONTROL AND THERMAL INSULATION

Insulation in homes today is considered as much a requirement as plumbing, lighting, heating, or any other modern necessity. Home owners in Alaska are vitally concerned with keeping heating costs low.

Drops of condensed moisture are often visible on the roomside of exterior walls which have insufficient insulation and are below the dew point temperature. This condensation on walls and ceilings can be eliminated by using enough insulation to keep inside surfaces above the dew point temperature.

In a typical home, the total heat loss is divided about equally between the outside walls, the ceiling and floor, the windows and doors, and various other air leakages normally called infiltration.

Undesired infiltration through windows and doors can be reduced by caulking, weather-stripping and tight fitting storm doors and windows. Other heat losses, totaling up to 50 per cent or more of the total losses, can be reduced by insulation.

It is important to insulate all heated areas from unheated areas such as an attached garage, storeroom, or enclosed porch. The ceiling under an unheated attic should be insulated or, if heated, the attic should be completely enclosed with insulation. Minimum recommendations for the amount of insulation are: six inches in the ceiling, three inches in the walls, three inches under the floor, and use of tight fitting storm doors and windows.

What adverse influence, if any, does insulation have on the moisture problem? The answer is none, provided that it is properly installed, that the design and assembly of accompanying materials is sound and that the generated water vapor within the house is properly controlled by ventilation or dehumidification.

The millions of properly insulated homes without any moisture problem testify to the beneficial influence of insulation. Every house that shows internal or hidden dampness due to condensation is violating one or more of the known principles of control whether it has insulation or not.

Recommended Moisture Control Procedure

Too frequently premature paint failures have been attributed to insulation, weather-stripping or storm sash, which is obviously unfair. Remember that these products properly used are sound and add much to weather protection, economy, safety and comfort in a shome. Troubles from excessive moisture may occur in a home with or without these materials when moisture is allowed to enter places where it should not be, and excessive humidity is permitted to exist indoors.

There is no reason why moisture damage or condensation should occur in any house if the following precautions are observed:

1. Recognition of the places where moisture enters the structure, with steps taken to eliminate it or prevent its entrance.

2. Proper use of vapor barriers to bar passage of water vapor into the structure's cold spaces, such as walls, floors and ceilings; and installation of methods to reduce the amount of water vapor within the house.

3. Cooperation by the occupants themselves in prompt repair of leaks, and by ventilating when dew or frost forms on single glass windows.

LIST OF REFERENCES

Branton, C. I. & Fahnestock, C. R., "Use of Native Alaskan Materials for Farm and Home Construction," Alaska Agricultural Experiment Station, Palmer, Alaska, 1954.

Britton, Ralph R., "Crawl Spaces," Housing and Home Finance Agency, Division of Housing Research, Washington, D. C., 1950.

Haeger, L. G., Britton, R. R., & Shuman, Lawrence, "Condensation Control in Dwelling Construction," Housing and Home Finance Agency, Washington, D. C., 1949.

National Mineral Wool Association, New York, N. Y., "How to Control Moisture in Homes."

Rowley, Frank B., Algren, Axel B., & Lund, Clarence E., "Condensation of Moisture and Its Relation to Building Construction and Operation," University of Minnesota, Engineering Experiment Station, Bulletin 18, 1941.

Rowley, Frank B. & Lund, C. E., "Vapor Transmission Analysis of Structural Insulating Board," University of Minnesota Institute of Technology, Engineering Experiment Station Bulletin 22, 1944.

Rowley, Frank B. & LeJoy, Millard H., "Some Causes of Paint Peeling," University of Minnesota Institute of Technology, Engineering Experiment Station Bulletin 30

Russell, William A., "Moisture Migration from the Ground," Housing and Home Finance Agency, Washington, D. C., 1954.

Weber, Charles G. & Reichel, Robert C., "Accumulation of Moisture in Walls of Frame Construction

During Winter Exposure," BMS 93, National Bureau of Standards, 1942.

Woolley, Harold W., "Moisture Condensation in Building Walls," National Bureau of Standards, 1940.

Date Due

JUL 14 '77

14094

Pam:697.147
BRA

BRANTON, C.I. and EATON, E.O.
AUTHOR

Condensation Control For Alaska Homes
TITLE

DATE LOANED	BORROWER'S NAME	DATE DUE
JUL 14 '77 JUL 7 '77	Sharon Rusk	JUL 14 '77

14094

BOREAL INSTITUTE
LIBRARY

University of Alberta Library
0 1620 0337 2586